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RESEARCH ARTICLE

An Exploratory Factor Analysis Approach to Investigate Health and Safety Factors in Indian Construction Sector

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Abstract

Construction sites require heightened safety measures due to hazardous working conditions. Health and Safety (H&S) standards in the Indian construction sector are notably subpar. Despite this stark reality, Indian researchers have paid scant attention to H&S concerns. Recognizing the critical dimensions is pivotal for enhancing on-site H&S. Thus, this study endeavours to identify the key aspects and factors influencing H&S at job sites within the Indian construction industry to prompt similar investigations in other developing countries. The research employed a pilot-tested questionnaire survey methodology to validate dimensions derived from existing literature. Following the compilation of a final set of 61 dimensions, Exploratory Factor Analysis (EFA) was applied for analysis. Among the original 61 dimensions, 35 were identified as significant and categorized into four main factors: Management Regulatory Factor (MRF), Worker's Self-Regulatory Factor (WSRF), Workplace Regulatory Factor (WRF), and Government Regulatory Factor (GRF) with Cronbach's Alpha 0.946, 0.892, 0.782 and 0.773 showing reliability level of excellent, good, acceptable and acceptable respectively which provides a theoretical framework. The study's outcomes can aid decision-makers, top management, and workers in comprehending H&S and its practical implementation.

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Additionally, the results may encourage developing countries to institute H&S governance for on-site safety. For future studies in the Indian construction sector, exploring these factors through Confirmatory Factor Analysis (CFA) is recommended. Based on the dimensions and factors identified in this research, a model utilizing structural equation modelling (SEM), or a Path Model could be devised. It is also advised that emerging nations conduct further research in this direction.

Keywords

H&S; Construction; Dimensions; Factors; EFA

Introduction

On-site health and safety (H&S) are a social responsibility and preventing zero building accidents worldwide is tough (Uddin, et al., 2023). Developing countries need to tackle H&S concerns adequately (Salvi, 2021). Consequently, H&S-related research provides evidence of initiatives to enhance H&S aspects of the construction industry (Upadhyaya and Malek, 2023a). Unfortunately, the sector continues to struggle with H&S issues, resulting in high death rates in construction activities (Newaz, et al., 2021).

India's construction sector employs 51 million people, second only to agriculture (Bandyopadhyay, 2022). Construction has a higher death rate than other Indian industries. Its mortality rate is 50 times higher than the US (incidents per 1,000 employees per year) (Chellappa, Srivastava and Salve, 2021). One in two thousand Indian construction workers is injured daily (Mahalingam and Levitt, 2007). This fact shows that the Indian construction sector has opportunities for H&S improvement.

Contractors in India are always looking for ways to save money, and the cost of buying protective gear for all of their workers is much higher than the money they give to injured workers as compensation. Indian contractors and employees feel safety precautions are only needed in extreme situations (Patel, Kikani and Jha, 2016). In India, most construction projects operate without a safety strategy (Chellappa, Srivastava and Salve, 2021). Industry operators and H&S-responsible agencies need more resources to manage H&S in construction. Thus, it is crucial to identify the fewest dimensions and factors most affecting construction safety performance (Yang, Kim and Go 2021). In this approach, those involved in the building project may direct their attention and available resources where they will have the most impact on ensuring the project's success in terms of H&S. Because construction activities are conducted in a variety of sociocultural, legal, and regulatory contexts, most H&S characteristics are country specific. Because of this, research conducted in other nations may not be relevant to the conditions of the Indian building sector (Upadhyaya and Malek, 2023b).

This research intends to fill the gap left by inadequate empirical investigations on the factors and dimensions that significantly impact health and safety on building sites in India. The twofold aims were set for the research to help accomplish this: (1) To identify the most critical sets of dimensions influencing construction H&S performance in India, and (2) To use the Exploratory Factor Analysis (EFA) approach to analyse the most influential dimensions influencing construction H&S performance. This research fills in the blanks by highlighting the primary dimensions and crucial factors contributing to H&S within the Indian construction industry.

Literature Review

Health is not merely the absence of disease; it is a state of complete physical, mental, and social well-being. This dynamic concept includes freedom from illness, the ability to engage in daily activities, mental stability, and supportive social connections. Beyond disease avoidance, health emphasizes overall quality of life and adaptability to challenges (McCartney, et al., 2019). Safety entails protection from harm, danger, or injury through measures designed to minimize risks. It applies to personal, workplace, product, and community contexts (Aven, 2014). The concept of H&S in construction refers to the systematic efforts and measures undertaken to protect the well-being of individuals involved in construction activities. It encompasses a comprehensive approach to identifying, assessing, and mitigating potential risks, hazards, and factors associated with construction sites, materials, equipment, and processes. The primary goal is to create a safe and secure working environment that minimizes the likelihood of accidents, injuries, and adverse health effects. Collaboration between workers, contractors, and regulatory bodies is crucial to fostering a safety culture that prioritizes the protection of individuals and the prevention of occupational incidents. Overall, the concept of health and safety in construction seeks to ensure the physical and mental well-being of everyone involved in construction activities, promoting a secure and productive work environment (Lingard, 2013).

Progressive Approaches for the Study: Kukoyi and Adebowale (2021) collected data via a questionnaire survey and, with the help of EFA, classified 21 hurdles to construction accident prevention into four variables and graded them based on the average score for the Nigerian construction sector. Buniya, et al. (2021) started with interviews; questionnaires were used to collect data, and exploratory factor analysis was used to classify 25 aspects of Iraq's building safety and categorized them into four categories. Ajith, Sivapragasam and Arumugaprabu (2019) used a questionnaire with a 5-point Likert scale and the Relative Importance Index (RII) to figure out the most important safety factors that affected how dangerous the work was. Through a literature review, Newaz, et al. (2021) did a systematic review and critical content analysis of the research literature to find five future research trends, gaps, and guidelines for construction safety management. They proposed a shift in research focus from physical safety issues to organizational and culture-related aspects that could improve safety effectiveness. The time series (TS) approach was used by Cao and Goh (2019) to find critical metrics of construction accidents. Three TS models were built for forecasting accident occurrences, and the vector error correction method was shown to be the most effective.

Conventional Approaches for the Study: Obolewicz and Dąbrowski (2018) In Poland, laws governing H&S were determined, a questionnaire survey was conducted, and Pareto charts were constructed to show that construction site managers' and employees' understanding of laws and regulations and their behaviour significantly impact OSH in small, medium, and large firms. Yiu, et al. (2018) identified key features and essential success criteria in Hong Kong by surveying the profession's status and structural interviews. The findings revealed a safety management system's advantages and possible implementation challenges. Chan, et al. (2017) noted three elements, namely: (a) "safety management commitment, safety resources, and safety communication;" (b) "employee's involvement and coworkers' influence;" and (c) "perception of safety rules, procedures, and risks." They claimed this research could be used to plan efficient safety management strategies for better safety outcomes. Akroush and El-Adaway (2017) showed that more prominent companies used leading indicators for their safety policies and plans. Instead of the system and policy-based hands, smaller organizations used straightforward, well-liked metrics like PPE use and housekeeping. Enshassi, Ayyash and Choudhry (2016) said that the most critical BIM safety applications to improve construction safety are "hazard detection and reduction" and "safety training and education." Guo and Yiu (2016) resulted in 32 highly rated indications and claimed that the primary indicators could not be considered separately when assessing the overall safety of a building project.

According to questionnaire data, Fang, et al. (2015) found that reactive and encouraging action affect worker safety behaviour but not safety climate. Training and preventative activity may increase construction site safety more than reactive and supportive steps by affecting the supervisory atmosphere and worker engagement. Mouleeswaran (2015), with the help of a questionnaire survey and the safety performance index, found that the level of safety in the Erode region needs to be improved. Hinze, Hallowell and Baud (2013) identified a wide range of safety procedures employed in the United States building industry through questionnaires, interviews, and site visits. Agumba and Haupt (2012) Using a questionnaire survey and the Delphi method, researchers in South Africa found 62 predictors with a high potential to boost H & S performance when taken into account. El-Mashaleh, et al. (2010) used a literature review and Data Envelopment Analysis (DEA) to benchmark safety performance. They found that the DEA method works well to fill gaps and evaluate contractors' safety performance.

Research Gap

Based on the literature, it is evident that numerous researchers have contemplated the evolution and transformation of H&S Management within their respective countries' construction sectors. Safety management practices in the construction industry are predominantly tailored to each country, with varying implementation requisites and methods across nations. Notably, the major problem is that safety performance benchmarking remains unexplored in India, leaving a void in determining the safety standards of the Indian construction industry. EFA is notably absent in the Indian context, contrasting with other publications that have employed more limited dimensions.

Exploration of Dimensions

An in-depth investigation was conducted to examine the various dimensions influencing H&S within the construction industry, drawing upon a comprehensive literature review spanning the last two decades. Based on a literature study, 61 variables were identified as influencing the H&S performance on-site in the Indian setting, as shown in Table 1. The researcher then addressed the explored dimensions with seven experts, three from academia and four from industry, with more than 25 years of expertise in this area Tripathi and Jha (2018), to ensure that no relevant variables pertinent to the Indian context were overlooked.

Table 1. Explored Dimensions for H&S in Construction from the literature

Sr. No.	Dimensions for H&S in construction	References
1	Safety training & safety related educational programs	[3], [5], [6], [7], [9], [10], [11], [12], [14], [15], [16], [18], [19], [20].
2	Safety incentives/Safety motivation / Safety promotional activities	[2], [5], [6], [7], [8], [10], [11], [12], [14], [15], [16], [18], [19].
3	Communication channels/systems	[1], [2], [4], [6], [9], [10], [13], [15], [16], [17], [18], [19].
4	Management commitment for H&S	[1], [2], [7], [10], [12], [13], [14], [16], [17], [18], [19].
5	Risk assessment/ Hazard identification/ analysis/ Job safety analysis	[5], [6], [7], [10], [12], [14], [15], [16], [17], [18], [19].
6	Onsite safety meetings	[2], [6], [7], [11], [12], [13], [15], [16], [17], [18], [19].
7	Onsite toolbox talk	[2], [6], [7], [11], [12], [13], [15], [16], [17], [18], [19].
8	Worker's/employee's involvement/ participation in H&S aspects	[1], [6], [10], [11], [12], [13], [14], [17], [18], [19].
9	Accident investigation	[5], [7], [12], [14], [15], [16], [17], [18], [19], [20].

Table 1. continued

Sr. No.	Dimensions for H&S in construction	References
10	Unsafe attitudes/Behaviours	[1], [2], [7], [8], [9], [13], [15], [16], [20].
11	H&S inspections	[6], [7], [11], [12], [15], [16], [18], [20].
12	H&S performance monitoring system/ evaluation/measurement/ assessment	[6], [7], [9], [11], [14], [15], [18], [20].
13	H&S organization/Safety Committee	[5], [6], [7], [10], [11], [14], [15], [20].
14	H&S plan	[6], [7], [11], [14], [15], [17], [18], [20].
15	Safety budget	[2], [6], [7], [12], [15], [16], [20].
16	Safety policy	[5], [6], [12], [15], [16], [17], [19].
17	Supply of PPE for workers	[5], [6], [8], [11], [15], [17], [19].
18	Safety rules	[1], [5], [9], [13], [15], [16], [19].
19	Safety audits by outside auditors	[6], [7], [10], [12], [15], [18], [19].
20	Emergency plan	[5], [7], [12], [14], [17], [19], [20].
21	Accident reporting system	[5], [10], [15], [18], [19], [20].
22	Housekeeping/ Drinking water/ Latrines & Urinals/Sanitation/ Accommodation/ Drug & Alcohol testing/ Healthcare facilities & Canteen facilities	[5], [6], [7], [8], [15], [19].
23	Peer & Time pressure	[1], [9], [13], [14], [16], [19].
24	Accident report analysis system	[5], [7], [11], [17], [18], [20].
25	Safety leadership	[2], [8], [10], [16], [18].
26	Working environment	[4], [10], [13], [16], [20].
27	Instructional manuals for H&S	[6], [13], [15], [16], [19].
28	H&S lesion learning & sharing	[2], [5], [8], [9], [11].
29	Unsafe working conditions	[2], [5], [8], [9], [11].
30	Current H&S rules &regulations	[3], [4], [20].
31	Worker's suggestions & feedback	[6], [7], [18].
32	Workplace layout considering H&S aspects	[5], [6], [8].
33	Fire control measures/ Electrical safety precautions/Machine Guarding	[5], [7], [20].
34	Absence of safety provisions in contractual clauses	[4], [10], [19].
35	Records keeping	[7], [11], [20].

Table 1. continued

Sr. No.	Dimensions for H&S in construction	References
36	Provision of insurance for labour	[3], [15], [19].
37	Training for special operations	[5], [19], [20].
38	Worker's right to refuse potentially unsafe work & unhealthy conditions	[6], [7], [8].
39	Influence of drug/alcohol/injury on work efficiency	[6], [7], [8].
40	Usage of PPE & Correct method of using PPE	[17], [19].
41	Risk-taking behaviours	[1], [9].
42	PPE & other safety equipment inspection & maintenance policy	[5], [7].
43	Teamwork of employees	[2], [10].
44	Induction training programs	[5], [15].
45	Lack of accident data management system	[3], [7].
46	Safety awareness	[3], [16].
47	Shift pattern & overtime	[3], [7].
48	Contractor & Subcontractor selection criteria	[2], [3].
49	Worker's age	[2], [6].
50	Extensive use of migrating labour	[3]
51	Lack of certifying authority to the H&S management system	[2]
52	Lack of onsite inspections by government authorities	[6]
53	Insufficient penalties	[3]
54	Inadequate support for innovation, research & technology	[3]
55	Contractors' negligence toward safety	[4]
56	Safe operating procedures	[5]
57	Outdated procedures	[5]
58	Worker's education & skill	[3]
59	Identification of implementation of H&S legislation	[4]

Sr. No.	Dimensions for H&S in construction	References
60	Negligence of work due to simplicity & repetitiveness	[5]
61	Worker's sincerity & professionalism	[2]

References are as follows: [1]= (Chan, et al., 2017); [2]= (Yiu, Sze and Chan, 2018); [3]= (Alkilani, Jupp and Sawhney, 2013); [4]= (Cheah, 2007); [5]= (Raja Prasad and Reghunath, 2011); [6]= (Agumba and Haupt, 2012); [7]= (Akroush and El-Adaway, 2017); [8]= (Guo and Yiu, 2016); [9]= (Wu, et al., 2015); [10]= (Karakhan, et al., 2018); [11]= (Alruqi and Hallowell, 2019); [12]= (Pereira, et al., 2018); [13]= (Alruqi, Hallowell and Techera, 2018); [14]= (Bavafa, Mahdiyar and Marsono, 2018); [15]= (Manu, et al., 2018); [16]= (Mohammadi, Tavakolan and Khosravi, 2018); [17]= (Tremblay and Badri, 2018); [18]= (Stemn, et al., 2019); [19]= (Zahoor, et al., 2016); [20]= (Tong, et al., 2018).

Research Methodology

Following the research flow shown in Figure 1, An understanding of on-site H&S concepts was acquired through a comprehensive literature review. The study delved into potential factors influencing H&S, and expert perspectives specific to the Indian context were sought. In this study, data was collected through a questionnaire survey using a Likert scale with five points. A questionnaire survey was used by Buniya, et al. (2021), Liang, et al. (2019), and Choudhry, Fang, and Lingard (2009) to investigate H&S issues on construction sites. The method used depends on what is being studied, and one of the benefits of questionnaire surveys is that data can be collected quickly (Kukoyi and Adebowale, 2021). According to Zahoor, et al. (2017), a questionnaire survey is an excellent way to determine people's feelings. For this type of study, several researchers, Trinh, Feng and Mohamed (2019), Newaz, et al. (2019), Bayram, Üngan and Ardıç (2017), and Ajith, Sivapragasam and Arumugaprabu (2019) used a Likert scale with five points. The data collected underwent initial processing in the pre-processing block. Subsequently, the dimensions of the pre-processed dataset were further reduced, and the EFA method was employed to cluster these dimensions.

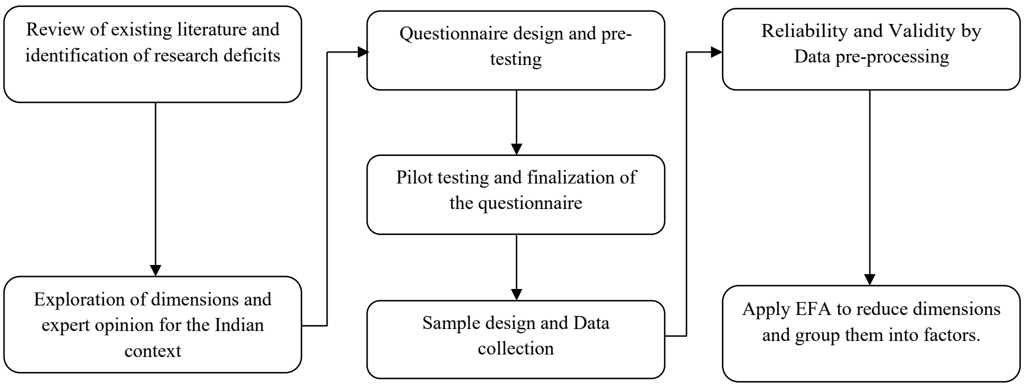

Figure 1. Research flow of the study

QUESTIONNAIRE SURVEY

The questionnaire comprised two sections: Section A had basic information about the respondent, and Section B contained 61 statements based on dimensions explored in the research topic on a five-point Likert scale from 1 to 5, where 1 means strongly disagree, and 5 means strongly agree. The pilot version of the questionnaire was filled out by 25 academicians and 25 industry professionals from all over India who work in civil engineering and have at least 20 years of experience. This data is not included in the final dataset. The questionnaire was evaluated for its reliability, usefulness, effectiveness, content validity, structural validity, offensiveness, unidirectionality, and unidimensionality. Their comments were utilized to amend the questionnaire. The finalized questionnaire was distributed to the population. To ensure the credibility of our findings, we need a significant sample size because civil engineering professionals from across India are hard to predict. The computation of sample size is detailed in depth in the next section.

SAMPLE SIZE

Two comparisons were used to determine the sample size. First, equation (1), given by Bartlett II, Kotrlik and Higgins (2001) was considered.

$$N=\frac{(t)^2*(s)^2}{(d)^2}=\frac{(1.96)^2*(0.8333)^2}{(0.15)^2}=\frac{3.841*0.694}{0.022}=121.18\approx 122 \qquad (1)$$

Where N= sample size, t= Value of selected alpha level (significance). The alpha level represents the researcher's confidence in a margin more significant than the minimum allowed margin of error. The alpha level is 5% for social science, engineering, management, etc., which is 0.05 & while the alpha level for medical studies is 1%, which is 0.01.t Value for alpha level 0.05 is 1.96, s= Variance estimation, Range of Likert scale = $6*s$ for 5 points Likert scale $5=6*s$, s= $\frac{5}{6}$ = 0.8333, d= Acceptable margin of error which is considered 3% for the Likert scale, d= No. of the point on the scale * acceptable margin of error, 5 * 0.03 = 0.15

Considering equation (1), the sample size would be 122 for this study.

Estimating a suitable sample size may also be obtained from (Malek and Bhatt, 2023; 2023a). They claim that a ratio of 5:1 between the sample size and the number of questionnaire statements is necessary for normal distribution. In light of this criterion, our sample size should be 305 since there are a total of 61 statements in our questionnaire. We acquired a sample size 305 using the second method, up from the 122 we got with the first. It was decided that a sample size of 335 would be appropriate, according to Bartlett II, Kotrlik, and Higgins (2001), with 10% oversampling to account for the fact that the two methods had different results. The KMO value, as shown in Table 3, is equal to 0.949, well above the acceptable threshold, indicating that the sample size is appropriate.

SAMPLING METHOD

The adoption of non-probability sampling methods, specifically purposeful/judgmental sampling, clusters of academics and industry professionals, and snowball sampling, is logically justified in the context of the impossibility of encompassing the entire population of civil engineering personnel in India for this study. Given the practical constraints of studying such a diverse and expansive population, non-probability sampling provides a pragmatic and efficient approach to gathering representative data. Purposeful/judgmental sampling allows for the intentional selection of participants based on their relevance and expertise, ensuring that the chosen clusters of academics and industry professionals possess valuable insights into the intricacies of health and safety within the construction sector. Snowball sampling further enhances the sample's diversity by leveraging the networks and recommendations of initial participants, contributing to a more comprehensive understanding of the subject matter. Overall, the application of non-probability sampling methods aligns with the study's practical considerations, maximizing the efficiency and feasibility of data collection while maintaining a representative and knowledgeable sample.

DATA COLLECTION

To cover all of India, five data collection zones were set up: North India, East India, South India, West India, and Central India. Eight states were evaluated in North India, ten states were evaluated in East India, five states were evaluated in South India, four states were evaluated in West India, and three states were considered in Central India. Following Table 2, created by the researchers of this paper, 335 responses were collected by considering the zone-wise area, development, and construction activities.

Table 2. Zoning of the entire India for data collection

No. and Name of Zone	States considered under the zone	No. of responses collected
Zone-1: North India	Jammu & Kashmir, Himachal Pradesh, Punjab, Uttarakhand, Haryana, Delhi, Uttar Pradesh, and Bihar.	60 (18% of total responses)
Zone-2: East India	Arunachal Pradesh, Assam, Nagaland, Manipur, Mizoram, Tripura, Meghalaya, Sikkim, West Bengal, and Odisha.	50 (15% of total responses)
Zone-3: South India	Telangana, Karnataka, Andhra Pradesh, Kerala, and Tamil Nadu.	57 (17% of total responses)
Zone-4: West India	Rajasthan, Gujarat, Maharashtra, and Goa.	114 (34% of total responses)
Zone-5: Central India	Madhya Pradesh, Chhattisgarh, and Jharkhand.	54 (16% of total responses)
Total responses collected		335 (100%)

CHARACTERISTICS OF RESPONDENTS

Responses were collected from academicians and industry professionals, considering their qualifications. In India, academicians are qualified with post-graduation or PhD degrees, while in most cases, diploma holders and graduates join the construction industry. In this research, 43% of respondents were academicians, and 57% of respondents were industry professionals. Among the 57% of industry professionals, a detailed analysis shows that 6% were owners or developers, 12% were contractors, 11% were project managers, 12% were safety officers, 11% were site engineers, and 5% were government-department civil engineers.

DATA PRE-PROCESSING

Pre-processing the data is crucial for ensuring the accuracy of the final results (Soewin and Chinda, 2018). In this research, the data acquired from the survey questionnaire are pre-processed in two steps: data coding and data cleaning. In data coding, statements were encoded to facilitate easy comprehension and software implementation. During the data cleaning process, each answer was looked at to see if there were any missing values. It was found that no statement had a missing value. The standard deviation of each respondent was also worked out to see if any answers were from people who were not interested. There are 35 replies with a standard deviation of 1, indicating that respondents selected any one number on the Likert scale throughout the questionnaire without reading or comprehending the statement. Finally, the dataset of 300 was accepted for analysis.

DATA ANALYSIS

The adoption of Exploratory Factor Analysis (EFA) in this study is logically justified as it stands as the predominant and widely accepted statistical approach for identifying health and safety (H&S) factors within quantitative data, according to the work of Choudhry, Fang and Lingard (2009). EFA systematically reduces dimensions and pinpoints relevant factors, providing a structured means to extract insights from complex datasets. Principal Component Analysis (PCA) supplements our analysis by organizing dimensions based on correlations, enhancing our understanding of variable relationships (Malek and Gundaliya, 2020). Varimax rotation further refines the factor structure interpretation by maximizing variance in factor loadings. The establishment of a 0.50 threshold for minimal factor loading, as suggested by Gao, et al. (2016), ensures the retention of dimensions with substantial relationships with an Eigenvalue greater than 1, following the recommendation of Malek and Zala (2021), adds a logical criterion for factor significance. This methodological sequence ensures our findings' precision, relevance, and practical applicability in unravelling the critical dimensions influencing H&S in the Indian construction industry.

Result and Discussion

FACTOR ANALYSIS

The EFA approach decreased the dimensions and retrieved the significant factors from those that remained. IBM's SPSS for Windows 25.0 software suite performed the EFA.

According to Choudhry, Fang and Lingard (2009), the Kaiser Meyer Olkin (KMO) value (a measure of sampling adequacy) should be greater than the acceptable threshold of 0.5 and a value greater than 0.6 is mediocre, >0.7 is middling, >0.8 is meritorious, and >0.9 is excellent for an EFA to proceed. In this study, the KMO value was equal to 0.949, well above the acceptable threshold, indicating that the data were appropriate for EFA. The correlation matrix was considered an identity matrix, so Barlett's test for sphericity was used to see if this was true. In this case, the value of the test statistic for sphericity is significant (chi-square value = 5934.736). The associated significance level is trim (p-value = 0.000), which means that the population correlation matrix is not an identity matrix (George and Mallery, 2019). An EFA would not mean anything if the population correlation matrix was an identity matrix. A significance value <0.05 indicates that the data do not produce an identity matrix or differ significantly from identity. The results of KMO and Bartlett's test are as per Table 3.

Table 3. KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0.949
Bartlett's Test of Sphericity	Approx. Chi-Square	5934.736
	df	595
	Sig.	0.000

The KMO measure and Barlett's test of sphericity were satisfied; hence, this study will apply EFA for dimension reduction and factor clustering. Further steps for EFA analysis are as per the below sequence.

In the next step, the anti-image correlation matrix was checked to identify each dimension's KMO value, which should be >0.6 according to Choudhry, Fang and Lingard (2009), and found >0.6 for all 61 statements. The number of statements was then reduced from 61 to 48 by merging some based on their similarity and the value of the rotated component matrix. The values of communality, which should be >0.4, were also examined (Costello and Osborne, 2005). In our study, we explored two assertions with communality values below 0.4 and had to eliminate them. As per Malek, Saiyed and Bachwani (2021), 11 statements were taken out of the study because their factor loading values were less than 0.5. A complete-dimension reduction process is as per Figure 2. As a result of applying this process, 35 statements remained for further study.

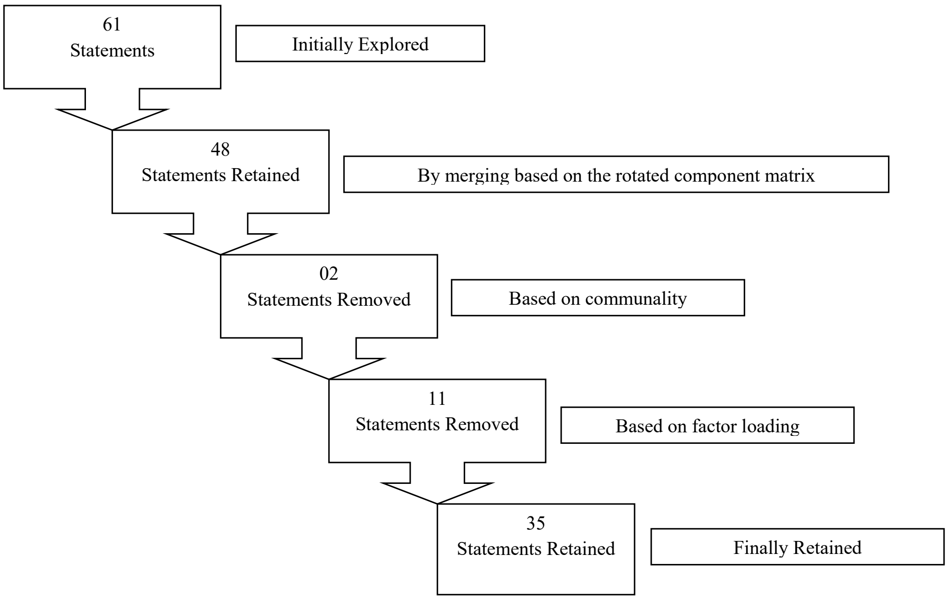

Figure 2. Dimension Reduction

After the statements have been whittled down and polished, the next stage is to divide the 35 statements into factors. A scree plot graphic helps to count the possible ways that sentences might be split apart (Choudhry, Fang and Lingard, 2009). Figure 3 shows a scree plot, which shows the elbow shape and suggests that the plot becomes flat after component 4, which means that the dimensions can be split into four groups.

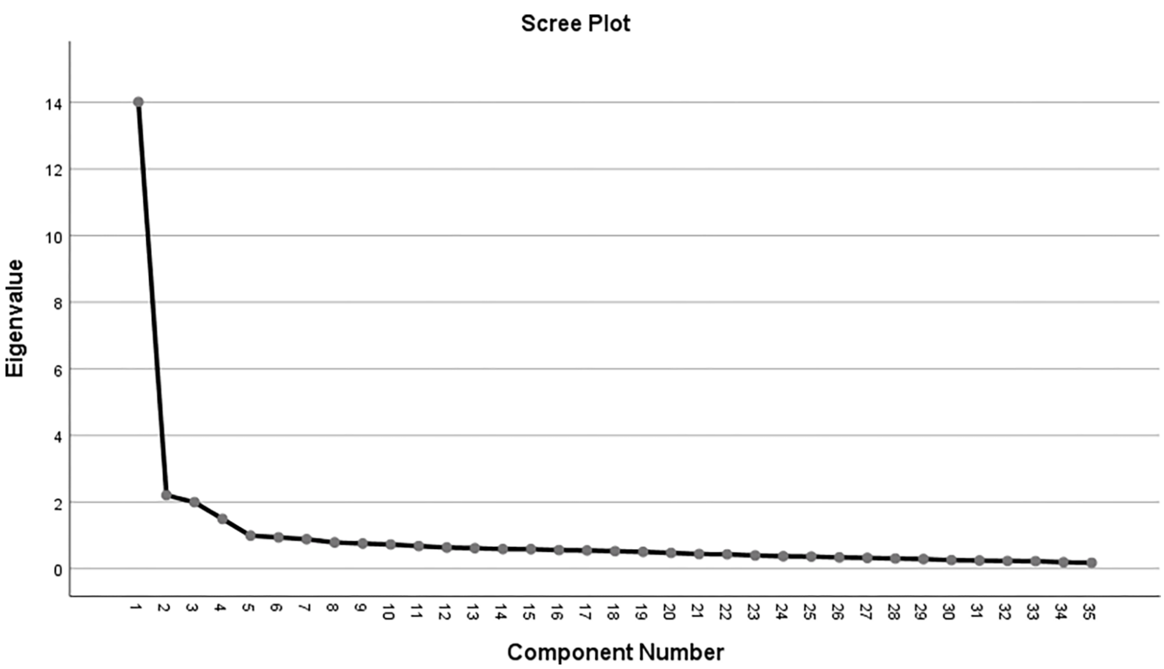

Figure 3. Scree plot of the 35 dimensions

As per Table 4, for the four factors, the eigenvalue for factor 1 is 14.013; for factor 2, it is 2.204; for factor 3, it is 1.993; and for factor 4, it is 1.491. The eigenvalue is greater than 1 for all four factors, which shows that the grouping is correct. The total cumulative variance explained in Table 4 is 40.036%, 46.333%, 52.028%, and 56.288% for factors 1, 2, 3, and 4, respectively. By observing the scree plot diagram Figure 3 and the total variance explained in Table 4, the 35 retained dimensions were distributed into four key factors. The factor matrix after rotation is as per Table 4.

Table 4. Grouping Results after Rotated Component Matrix for factors

Dimension	Factors			
	1. MRF	2. WSRF	3. WRF	4. GRF
Emergency Plan	0.792			
Safety meetings, Induction training, and other safety measures	0.745			
Health and safety plans	0.707			
Hazard identification	0.691			
Management commitment and implementation of legislation	0.682			
Safety audits	0.677			
Accident report analysis considering teamwork and instructional manuals	0.675			
Safety performance monitoring and record keeping	0.672			
Accident Investigation	0.668			
Safety training and training for special operations	0.661			
Accident recording and reporting system	0.657			
Safe Operating Procedures	0.655			
Safety budget for Personal Protective Equipment	0.648			
On-site health and safety Inspections	0.611			
Labor welfare facilities	0.569			
Health and safety organization and safety committee	0.554			
Worker's Unsafe Attitudes and Unsafe Behavior		0.708		
Proper usage of Personal Protective Equipment		0.700		
Risk-taking behaviours of workers		0.676		

Table 4. continued

Dimension	Factors			
	1. MRF	2. WSRF	3. WRF	4. GRF
Employee's involvement in health and safety aspects		0.655		
Workers' right to refuse potentially unsafe work		0.626		
Unsafe working conditions		0.568		
Workers' Sincerity and professionalism		0.558		
Workers' suggestions & feedback		0.515		
Outdated procedures			0.713	
Shift Patterns and overtime			0.618	
The age of workers			0.617	
Peer pressure and time pressure			0.610	
Extensive involvement of migrated labour			0.593	
Lack of awareness and negligence of health and safety aspects during repetitive and simple work			0.555	
Lack of on-site inspections by Government authorities				0.769
Lack of certifying authority to health and safety management system				0.712
The absence of health and safety provisions in contractual clauses				0.700
Inadequate government support for innovation and research				0.683
Lack of accident data management system				0.600
Eigenvalue	14.013	2.204	1.993	1.491
Total Variance Explained (%)	40.036	6.297	5.695	4.260
Total Cumulative Variance Explained (%)	40.036	46.333	52.028	56.288
Cronbach's Alpha for factors reliability test	0.946	0.892	0.782	0.773
Reliability Level	Excellent	Good	Acceptable	Acceptable

Cronbach's coefficient alpha was used to analyse the four factors' reliability. It evaluates the internal consistency of a set of variables to measure a single factor. Factors typically simplify many dimensions. Inferring the component from other variables is necessary as the factor cannot be calculated directly. This study's characteristics make Cronbach's alpha test suitable for assessing factor grouping. According to Pereira, et al. (2018), a group is excellent, good, acceptable, questionable, poor, or unacceptable if Cronbach's Alpha is > 0.90, between 0.80 and 0.89, between 0.70 and 0.79, between 0.60 and 0.69, between 0.50 and 0.59, and < 0.59, respectively. As per Table 4, we have achieved values for all four factors higher than the acceptable value of > 0.7.

DISCUSSION

Table 4 shows H&S factors by their reliability level. A new underlying factor was named after its dimensions. The recommended factor term is subjective. Thus, other studies may use a different label (Choudhry, Fang and Lingard, 2009). However, the four named underlying factors are as follows.

FACTOR 1: MANAGEMENT REGULATORY FACTOR

Factor 1 comprises 16 different dimensions that are all related to the management of the construction industry. The management of the building firm must control these factors. Before commencing work, managers must prepare health and safety plans and emergency plans and identify potential hazards (Tong, et al., 2018). For the same thing to happen, the management must be committed and check the implementation of H&S legislation (Cheah, 2007). Management should prioritize H&S training, induction programs, special operations training, and safety meetings to inform personnel of safe operating procedures (Zahoor, et al., 2016). Management must schedule frequent H&S audits and inspections by outside auditors (Agumba and Haupt, 2012). Management should establish an internal safety committee (Manu, et al., 2018). Mohammadi, Tavakolan and Khosravi (2018) say that each project should have enough money for safety, including personal protective equipment. Management should establish a mechanism for accident recording, inquiry, and report analysis that considers whether teamwork and instructional manuals were followed (Newaz, et al., 2021). Management should offer appropriate housing and sanitation with housekeeping, drinking water, a canteen, healthcare, and drug and alcohol testing to promote labourers' health (Akroush and El-Adaway, 2017). Management must monitor safety performance (Alruqi and Hallowell, 2019).

FACTOR 2: WORKER'S SELF-REGULATORY FACTOR

Factor 2 has 08 self-protection parameters that workers can only regulate. The employee is responsible for controlling their attitude and behaviour since unsafe attitudes and behaviours might result in health risks and accidents (Chan, et al., 2017). Workers may value and use PPE properly to avoid accidents (Tremblay and Badri, 2018). Some jobs require risk-taking, but employees must be mature and follow all safety procedures before beginning (Wu, et al., 2015). On-site personnel should know they may reject risky activities (Guo and Yiu, 2016). Identifying unsafe working conditions requires sincerity and professionalism. Since they work on-site, employees' suggestions and feedback may enhance H&S (Yiu, Sze and Chan, 2018).

FACTOR 3: WORKPLACE REGULATORY FACTOR

Factor 3 consists of 06 dimensions that are highly influenced by the workplace. Sometimes, outdated procedures are followed at the workplace, which may not be compatible with new technologies and lead to accidents (Raja Prasad and Reghunath, 2011). Shift patterns may need to be corrected, and workers may not have a chance to talk about work that has been done, work that still needs to be done, or any ongoing operations or processes that could be dangerous (Alkilani, Jupp and Sawhney, 2013). There must be a limit for overtime. Laborers are poor and often work more hours than they can manage, which can harm their health or cause accidents. Hence, there must be some specific workplace overtime rules (Akroush and El-Adaway, 2017). The age of labour directly affects work efficiency. Older labourers may have many health issues and need more work efficiency. Considering this in the construction industry, there should also be age restrictions for labourers. Zahoor, et al. (2016) say that accidents on the job site can be caused by peer pressure and the need to finish the work quickly. In the construction industry, specialized labourers for particular operations are unavailable. Hence, to execute such operations, labourers are migrated from other locations. Working with migrated labourers is very much complex in many aspects. Due to misunderstandings in language and communication, workplace hazards and accidents are taking place (Alkilani, Jupp and Sawhney, 2013). Negligence of H&S aspects during repetitive and straightforward work and awareness is also a vital issue considering under the umbrella of workplace regulatory factor.

FACTOR 4: GOVERNMENT REGULATORY FACTOR

Factor 4 consists of 05 dimensions that directly deal with the government's actions. The government should be considered central or state, whichever is the appropriate government. The government should set up a body that certifies projects, not companies or contractors, by ensuring that their H&S management systems follow the law. Only frequent government on-site inspections can enforce H&S legislation (Elsebaei, et al., 2020). It might be challenging to improve the performance of H&S when there is neither an independent certifying body nor regular on-site inspections by government agencies. Since each construction project is unique, contractual clauses should include project-specific H&S requirements for on-site implementation (Ndegwa, et al., 2014). Failure to achieve H&S in the construction sector may also result from a lack of accident data management systems and insufficient government support for innovation and research in construction.

Theoretical Implications

The identification of 61 dimensions and the subsequent refinement to 35 through EFA underscores the nuanced nature of H&S concerns in construction settings. This recognition is theoretically significant as it contributes to a more comprehensive understanding of the multifaceted factors influencing on-site H&S. The categorization of the 35 dimensions into four distinct factors (Management Regulatory Factor, Worker's Self-Regulatory Factor, Workplace Regulatory Factor, and Government Regulatory Factor) provides a theoretical framework for understanding the interplay of various elements in influencing H&S outcomes. This categorization aids in conceptual clarity and lays the groundwork for future theoretical developments in the field. The acknowledgement of limited attention given to H&S concerns in the Indian construction sector by researchers highlights an academic gap in the existing literature. This study fills this void by emphasizing the importance of investigating and addressing H&S issues within India's construction industry. Using a pilot-tested questionnaire survey methodology and subsequent application of EFA demonstrates a robust and replicable research methodology. The theoretical implication lies in the potential adaptation and application of similar methods in diverse settings, contributing to the development of standardized approaches for studying H&S in construction. The study's theoretical implications extend to emerging nations, urging them to undertake further research to understand and improve H&S in their construction sectors. This speculative call to action encourages the global academic community to contribute to a more robust theoretical foundation for H&S management in diverse contexts.

Practical Implications

The results of this study fill a gap in the literature by providing new information on H&S in India's construction sector. The results also provide direction to industry practitioners and India's central and state governments on the critical dimensions and factors that should be considered to boost H&S performance. Decision-makers, upper management, and workers on the project may all embrace the study's results better to grasp the significance of H&S and its successful implementation. The upper management of all the Indian construction firms is recommended to address and enhance the management regulatory factor. The workers are encouraged not to neglect the worker's self-regulatory factor. The dedicated teams within construction companies should focus on overseeing the workplace regulatory factor. It is recommended that the central and state governments across India carefully consider, amend, and effectively implement government regulatory factors. In addition, a manual outlining the H&S attainment methods for the identified variables that would improve ongoing and future building projects may be compiled.

Conclusion

Globally, the building industry grapples with the pervasive challenge of suboptimal H&S performance. While strides have been made in the industrialized world, where noteworthy advancements in H&S have yielded tangible and gratifying results, developing nations must catch up due to their predominant focus on economic priorities.

To delve deeper into the complexities of workplace H&S, this study conducted an extensive literature search, identifying a comprehensive list of 61 dimensions influencing H&S within the construction sector. Subsequent to collecting questionnaire data, an EFA was employed to streamline the dimensions, resulting in a refined set of 35 dimensions. These dimensions were then categorized into four distinct factors: the Management Regulatory Factor, the Worker's Self-Regulating Factor, the Workplace Regulatory Factor, and the Government Regulatory Factor.

It's crucial to note that the respondents in this study were exclusively selected from within India. Consequently, the scope of this research is confined to the Indian construction sector, which has long grappled with issues such as an absence of safety culture and limited safety research. To address these concerns and contribute to policy enhancement, this study concentrates on identifying, reducing, and organising H&S dimensions within the Indian construction context.

By elucidating the intricacies of these dimensions and their alignment with regulatory frameworks, this research aims to provide valuable insights for refining policies, rules, regulations, and laws about H&S in the construction sector. The ultimate goal is to bolster safety performance within the Indian construction industry. Moreover, the findings of this study are poised to serve as a blueprint for other developing nations facing similar challenges, encouraging them to view H&S management as a viable avenue for overall improvement.

Ultimately, this research not only uncovers and categorizes critical dimensions influencing H&S within the Indian construction sector but also aims to contribute to the broader discourse on global H&S management practices. By doing so, it aspires to inspire positive change, fostering a safer and more secure working environment in India and developing nations worldwide.

Future Scope

The present study achieved its aims and produced a few ideas for further investigation. Confirmatory factor analysis (CFA) can be used to verify the reliability of the measuring scale and examine the correlations between the factors and model by structural equation modelling (SEM), or a path model can be developed in future studies for the Indian construction sector using the dimensions and extracted factors described in this work. The scope of this research was confined to the Indian construction industry. Hence, it is recommended that a similar study be extended to include other emerging countries.

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